Qatar Foundation: EPC of SCADA System at Education City

City & Facility Management

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Qatar Foundation
Unlocking Human Potential

Qatar Foundation for Education, Science and Community Development (QF) was established in 1995 by:

• His Highness, The Father Emir, Sheikh Hamad Bin Khalifa Al Thani

• Her Highness, Sheikha Moza Bint Nasser Al Misnad (Chairperson)

QF is a non-profit organization where centers and programs focused on education, research, innovation, and community development intertwine for the benefit of Qatar, and the world.
12 SQUARE KILOMETERS
The challenge

- Many facilities have their local BMS from different manufacturers
- An OWS from every facility is added in the 2 Central Control Rooms (CCR) of Education City
- South Campus facilities were connected to CCR 1
- North Campus facilities were connected to CCR 2
- Individual OWS to monitor and control every facility in the CCR has made the CCR very cluttered
- Manual energy recording and reporting are followed
- Not able to determine cooling energy wastages due to improper scheduling and not having energy management in place
- A lot of manpower were needed to locally monitor and control every facility
### Various BMS at Education City Facilities

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<tr>
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<th>BMS</th>
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<td>Central Plant 1 Utility Tunnel</td>
<td>Honeywell</td>
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<td>North Utility Tunnel</td>
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<td>Central Plant 7</td>
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<td>Convention Centre (QNCC) &amp; QNCC Extension</td>
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<td>InTouch (Wonderware)</td>
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Project overview

45 facilities are integrated to SCADA with independent local control & Centralized control from CCR

Phase 1
- 2 Sites

Phase 2
- 40 Sites

Phase 3
- 3 Sites

Future Expansion
- More Facilities

45 Facilities are Integrated

29 Sites Hardware Installation

207 Virtual Machines using Microsoft Hyper-V setup

64 Server Hardware
- 37 OWS
- 2 EWS
- 6 TWS

The Sites are combined to a single galaxy to reduce hardware count

to reduce hardware count and achieve more from a single hardware

ECS, QAST, Academyati, etc...
The solution - AVEVA components

Addressing the needs of centralized monitoring and control

- **Foundation**
  - AVEVA Operations Control 2023
    - Redundancy
    - Scalability
    - Security

- **Visualization**
  - AVEVA Intouch HMI
    - HMI software for control room
  - AVEVA Intouch Access Anywhere
    - For remote monitoring from inside and outside QF
    - Alarm management
    - Trends

- **Tools for Operations**
  - AVEVA Historian
  - Custom Reports using AVEVA Reports for Operations
  - Automated Daily, Monthly Reports generation & delivery using email
  - CAFM Integration for raising work request directly from AOC 2023
  - Custom time-based scheduler
SCADA design guidelines and principles

The Master Solution incorporates existing guidelines and standards from industry best practices, AVEVA Software development practices, and Qatar Foundation Standards to deliver the SCADA system.

Design Guidelines and Principles

- Centralized Control and Independent local operations
- Simplify and streamline
- Accessible by operators from remote
- High Availability
- Redundant solution
- Standardizing operations
- Minimizing energy usage through scheduling
- Scalable for future expansion

Unified Operation Platform – AOC 2023

- Resilience
- Standardization
- Distributed System Architecture
- Centralized Control CCR 1 & 2
- Independent Local Operations
- Reusability
- Scalability
- Flexibility
Overall system architecture

- **316,000 Data Points**
- **Upgraded to 500,000 licenses in total for future expansions**

**Facilities/Buildings**

**QF OT Network**

**AVEVA Servers**

- Redundant SWSCADA servers
- Hardware SAM
- Domain Controller
- Terminal servers

**Training Room (CCR 2)**

- TWS1
- TWS2
- TWS3
- TWS4
- TWS5
- TWS6

**Command Center Room (CCR 1 & 2)**

- 4 OWS & 1 EWS in Central control rooms
- Each Workstation will have a client license which include: AVEVA InTouch

**Remote users (using Intouch Anywhere Access)**

**CAFM Integration**

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Trainings and Simulations using 6 TWS are performed in this room for the Operators / Supervisors.
Operator training

Training and simulation

- Operators were given hands-on training on SCADA system by AVEVA certified trainer
- Operators were given in-depth knowledge on SCADA philosophies, design principles, Architecture, communication, navigation, alarm management, scheduling, reports, trend analysis, CAFM integration etc.
- Training recordings are made available for new operators
- Process simulation were also conducted for hands on experience
AVEVA InTouch HMI - overview

The following table lists the hierarchy of the SCADA application

<table>
<thead>
<tr>
<th>Style</th>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>Overview Map</td>
<td>0</td>
<td>Level 0 screen shows the Site Wide Overview gives a bird’s eye view on Education City Masterplan where the facilities are mimicked as well as the total number of alarms associated with each facility</td>
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<tr>
<td>Facility Dashboard</td>
<td>1</td>
<td>Level 1 Building Dashboard shows KPIs for the entire facility, subsections includes CHW, HVAC, Electrical, Life safety etc.</td>
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<tr>
<td>Equipment Dashboard</td>
<td>2</td>
<td>Level 2 screens contain objects depicting KPIs for equipment in each facility / floor</td>
</tr>
<tr>
<td>Process Graphics</td>
<td>3</td>
<td>Level 3 screens typically provide detail on a specific piece of equipment, process, or area</td>
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<tr>
<td>Faceplate</td>
<td>4</td>
<td>Level 4 screens are pop-up style screens that are displayed when the user clicks on a component</td>
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</tbody>
</table>
Level 0 – Site Wide Overview
Level 1 – Building Dashboard

Water tank level, pressure is displayed using this bar indicator.

Key parameters in CHW - building supply temperature are displayed in the form of trend.

Two different temperature values. Building supply & return and its difference (delta) is displayed.

Pumps, generator etc. status and alarms are shown using this symbol.
Level 2 – Equipment Dashboard

VAV Process
Value & Feedback

AHU Key parameters

FCU Process
Value & Feedback
Level 3 – Process Graphics

If any alarm is active in the equipment, then a red border appears.

White color displays the equipment is not running.

Grey color shows the equipment is running.
Level 4 – Faceplate

- CAFM Button
- Run Hour Statistics
**Better Visibility – Equipment Availability and Reliability**

### CP1 SCADA Application: Equipment Availability & Reliability

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<tr>
<th>Building</th>
<th>Description</th>
<th>Total Scheduled #Hr (hrs)</th>
<th>Total Hourly Outage (hrs)</th>
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<th>Reliability (%)</th>
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### Better Visibility – Equipment Summary

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<tr>
<th>Building</th>
<th>Floor/Location</th>
<th>ID</th>
<th>Sup. Air Temp (°C)</th>
<th>Mod Fdbk Air Temp (°C)</th>
<th>Supply Humidity (%)</th>
<th>Supply Fan Status</th>
<th>Mod. Fan Status</th>
<th>Supply Fan Feedback (%)</th>
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<td>10.00</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CP6-0006</td>
<td>GF.P4-G19</td>
<td>OAHU-0001</td>
<td>14.07</td>
<td>--</td>
<td>--</td>
<td>Running</td>
<td>--</td>
<td>29.00</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CP6-0006</td>
<td>LRF</td>
<td>AHU-0010B</td>
<td>18.88</td>
<td>19.97</td>
<td>--</td>
<td>Running</td>
<td>--</td>
<td>13.00</td>
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<td>--</td>
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<tr>
<td>CP6-0006</td>
<td>LRF</td>
<td>AHU-0011</td>
<td>17.76</td>
<td>22.00</td>
<td>--</td>
<td>Running</td>
<td>--</td>
<td>17.00</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CP6-0006</td>
<td>LRF</td>
<td>AHU-0012</td>
<td>14.49</td>
<td>22.03</td>
<td>--</td>
<td>Running</td>
<td>--</td>
<td>22.00</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>CP6-0006</td>
<td>LRF</td>
<td>AHU-0013</td>
<td>15.72</td>
<td>22.04</td>
<td>--</td>
<td>Running</td>
<td>--</td>
<td>29.00</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>
Custom reporting and analysis

AVEVA Reports for Operations (Dream Report) are used as the Custom Report Tool

• Key Features
  o Leverages all archives from other solutions and applications such as SCADA, Historians
  o Integrates in one user-friendly environment all tools to easily create and generate automated Reports
  o Enables Print, Archive, Email and Reports Publishing over the web automatically

• Custom Automatic Reports configured currently are:
  o Central plants Daily Reports
  o Central Plants Monthly Reports
  o Flow Meter Reports
  o Alarms Report
  o Facilities Daily & Monthly Reports
# Automatic Custom Reports for Cooling Energy Analysis

## Report Period: 02/09/2023

### Qatar Foundation - Education City - Site Wide SCADA - CP2 Daily Report

### CP5 Operations Report - DAILY

### CP5 - Equipment Status

<table>
<thead>
<tr>
<th>ID</th>
<th>Equipment</th>
<th>01</th>
<th>02</th>
<th>03</th>
<th>04</th>
<th>05</th>
<th>06</th>
<th>07</th>
<th>08</th>
<th>09</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>OFF</td>
<td>OFF</td>
<td>R</td>
<td>R</td>
<td>OFF</td>
<td>OFF</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
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<tr>
<td></td>
<td>Chiller Load (%)</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>9</td>
<td>2</td>
<td>0</td>
<td>87</td>
<td>88</td>
<td>88</td>
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<tr>
<td></td>
<td>Cooling Towers Status</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>R</td>
<td>OFF</td>
<td>R</td>
<td>R</td>
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<tr>
<td></td>
<td>Cooling Towers (VFD Speed %)</td>
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<td>0</td>
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<td>0</td>
<td>50</td>
<td>0</td>
<td>15</td>
<td>50</td>
<td>46</td>
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<tr>
<td></td>
<td>Condenser Pumps</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>Primary pumps Status</td>
<td>R</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>Secondary pumps Status</td>
<td>OFF</td>
<td>OFF</td>
<td>R</td>
<td>OFF</td>
<td>R</td>
<td>OFF</td>
<td>OFF</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Secondary pumps (VFD Speed %)</td>
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<td>41</td>
<td>0</td>
<td>41</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Tertiary pumps Status</td>
<td>OFF</td>
<td>R</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

A = Available; NA = Not Available; OFF = Not Running; R = Running; L = Local; REM = Remote; RA = Auto; --- = Not Installed; NA = Bad value
## CP5 - Cooling Tower Supply, Return (°C)

<table>
<thead>
<tr>
<th>Date</th>
<th>Supply</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/02/2023</td>
<td>38.33</td>
<td>30.13</td>
</tr>
<tr>
<td>09/01/2023</td>
<td>37.5</td>
<td>30.01</td>
</tr>
<tr>
<td>09/03/2023</td>
<td>38.15</td>
<td>30.14</td>
</tr>
</tbody>
</table>

### Condenser System

- **Wet Bulb Temperature (°C):** 24.3
- **Condenser Water Flow (gpm/Pump):** N/A
- **Supply to Cooling Tower Temp (°C):** 40.8/34.24
- **Return from Cooling Tower Temp (°C):** 35/38.33
- **CT Make-Up Water Daily Consumption (m3):** 1784042.62

### CPS Building Data

- **Building CHW Tertiary DP (Pa):** 0.9
- **Building CHW Total Flow (gpm):** 835 gpm
- **CHW Bldg Sup/Rtn Temp. (°C):** 5.6/14.4
- **CHW CP Sup/Rtn Temp. (°C):** 5.6/14.4

*Readings are taken at 13:00 hrs*
Qatar Foundation - Education City - Site Wide SCADA - CP2 Daily Report
CMC Chilled Water System Analysis - DAILY

Report Period: 01/09/2023

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Design Value/Unit Values</th>
<th>Actual Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water System (kW)</td>
<td>5.5 - 14.5</td>
<td>5.2</td>
</tr>
<tr>
<td>CP side CHW Supply Temp. (°C)</td>
<td>6.5 - 14.5</td>
<td>13.9</td>
</tr>
<tr>
<td>CP side CHW Return Temp. (°C)</td>
<td>7.5 - 14.5</td>
<td>7.35</td>
</tr>
<tr>
<td>Building side CHW Supply Temp. (°C)</td>
<td>7.5 - 15.6</td>
<td>15.30</td>
</tr>
<tr>
<td>Building side CHW Return Temp. (°C)</td>
<td>7.5 - 15.6</td>
<td>-</td>
</tr>
<tr>
<td>CP side Flow (l/s)</td>
<td>2756 - 2773 gpm</td>
<td>823.7</td>
</tr>
<tr>
<td>Building side Flow (l/s)</td>
<td>2796 - 2773 gpm</td>
<td>894.7</td>
</tr>
<tr>
<td>Building CHW Tertiary DP</td>
<td>-</td>
<td>--</td>
</tr>
</tbody>
</table>

*Readings are taken at 13:30 hrs

CMC - District and Building side Energy (kW)

District Energy (kW): 1702.36
Building Energy (kW): 1686.44
Daily CHW Energy Calculation (kWh): 4466.43

CMC - District and Building side Energy Rate (BTU/hr)

CMC - CP side Supply, Return & Delta Temp (°C)

CMC - Building side Supply, Return & Delta Temp (°C)

CMC - District and Building side Flow (l/s)

Potable Water Tank Cap: 90 m³

NA = Not Available; N/A = Bad value

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Central Plant Energy Production Dashboard
Central Plant Energy Consumption Dashboard and Trends
Remote Control of XL10 LON Controllers Network Setpoint from AOC 2023 – Challenge

- Use Network set point checkbox is utilized to allow the operator to input a set point from the Remote OWS when the checkbox is checked in the Local BMS
- The factory setting of this checkbox was disabled to prevent the Remote Operator from controlling the equipment
- The checkbox OPC I/O cannot be exposed for VAV, CAV, FCUs that are implemented using XL10 LON controllers in 6 facilities
- This check box could be accessed from the local BMS (EBI - Honeywell) only to change the controller settings
Remote Control of XL10 LON Controllers Network Setpoint from AOC 2023 – Challenge Resolution

- We have implemented scripts for VAV, CAV, FCU LONworks points in Local BMS to enable navigation to Instruction display screen whenever the check box is checked from AOC 2023 VAV/CAV/FCU faceplates.
- Each VAV/CAV/FCU associated display points were modified for navigation to faceplates.
- By doing these script changes in local BMS we were able to control Network Setpoints for VAV/CAV/FCU’s equipped with LONworks XL10 controllers.
- We have achieved considerable cost savings to Qatar Foundation.
Water Meter Management

QF were able to identify a leakage in one of the sub header lines on 5th August 2023 utilizing the High Alarm set for Al Shaqab Flow meter

- Facilities water usage at night is less compared morning due to unoccupancy
- Average water usage at Al Shaqab facility is around 35 m³/Hr at night
- On the 5th August 2023 at night water usage peaked to 84 m³/hr due to a leakage in the sub header
- High flow alerted the remote operator on his cell phone, and local operators were able to bypass the line and avoid huge wastage and cooling water
Optimum Energy Utilization

Electrical Consumption is considerably reduced, and Chiller Plant efficiency has improved from previous years average from 0.91 kW/TR down to 0.86 kW/TR leading to 5.5 % cost reduction to QF.

- Performance of the District Cooling Plants and Energy Transfer Stations are continuously monitored 24/7.
- Real time diagnostics of all operating systems and equipment for higher reliability and lower operating costs.
Planning and Scheduling

Scheduler is a calendar-based programming tool that allows a user to manipulate tag values. It can be used to create a sequence of automatically executed commands.

- The Time Scheduler is used to manage the lighting, heating and other sub systems in a building, providing benefits such as automated services
- Simple on/off commands, multi-state and multiple tag variations can be configured
- Scheduler allows exchange of data between control system devices related to the establishment and maintenance of dates and times at which specified output actions are to be taken
- Interoperability in this area permits the use of date and time schedules for starting and stopping equipment and changing control setpoints as well as other analog or binary parameters
- Scheduler provides different configuration and type of events. Schedule can be time based or condition based
- When the event condition or specified time is met, scheduler writes the user specified value to the attributes/tag name
Run Hours + Statistics + CAFM Integration

AOC 2023 Integration with Computer Aided Facility Management (CAFM) enables Facility Managers to plan, execute and monitor all activities involved in reactive and planned preventative maintenance, asset management and operational facility services.

- Faceplate can be used for monitoring and controlling equipment
- It also shows statistical information like
  - Equipment Status
  - Equipment Total Run hours
  - Start Count
  - Last Run date
  - Trip Count
Raising Work Request straight from Equipment faceplate

During PPM users can reset the run count & trip count to analyze the running conditions of the equipment, if certain conditions reached user can raise work request to service the equipment by clicking CAFM button available on the faceplate.
Equipment Alarms

The Operator can easily configure the supervisory Alarms, acknowledge them and take immediate action
Project Goals are Achieved

The implementation of a Unified Operation Platform by means of AOC 2023 is the cornerstone for the transformation of Education City into a SMART City.

• Qatar Foundation has achieved 2 State of the Art Central Command Centers to Monitor and Control 45+ facilities at Education City.

• The achieved key goals are:
  o Reduction of Education City carbon footprint through optimum energy consumption
  o Reliable and redundant operation solution
  o Secure – AVEVA cyber security standards, QF OT firewall
  o Accessible from anywhere using InTouch Access Anywhere
  o Fully Documented System
  o Scalable Platform for future expansion
  o Easy operation & Easy to train operators
  o Operation excellence using better reports, alarm management, trends and CAFM integration
  o Energy consumptions controls and trend data availability
Future enhancements of the system
As future enhancement to the Unified Operating Platform QF is looking to implement

- Asset Performance Management
- Energy Management solutions
- Smart meter integration with AOC 2023
- Future expansion of SCADA to monitor & control of other facilities like QA Sidra, Education City Stadium, etc.
Reduction of Education City carbon footprint through optimum energy consumption

Challenge

• 12 sq km campus with 45+ buildings including educational, hospital, recreational, industrial, and sports facilities.

• Diverse makes and models of existing controls across facilities with inconsistency visualization, trending, and reporting interfaces.

• Difficulty to control and monitor all operations from centralized control rooms.

Solution

• Deployed AVEVA Operations Control to streamline process visibility and centralized control. Utilizing a high availability architecture design enabling operation from two command centers interconnected throughout all facilities.

Results

• Centralized control and independent monitoring & Control for over 45+ facilities

• Better visibility to information has led to 5.5 % reduction in energy consumption, optimum energy utilization, and enabled more reliable operations performance

• Corner stone for smart city transformation at QATAR Foundation Education City through a unified operation platform

• Streamlined operator training due to standardized design and function

“AVEVA Operations Platform aligns Education City with our leadership’s vision to transform it into a Digital Smart City, controlled from a centralized command center to attain optimum operability and to provide necessary information for decision making for our prestigious facilities to reduce their carbon footprint and O&M costs.”

Georgios Sichanis, SPM, ASTAD
Distinctive Appreciation goes to the professional AVEVA team members who have successfully delivered the EPC of SCADA System for Qatar Foundation at Education City

Team Members Acknowledgment

- Mohsen Sorour
- Abdul Mobeen
- Bradley Christison
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- Hitesh Gowan
- Nafeesul Farouqi
- Rajneesh Tiwari
- Dharmesh Patel
- Sanjay Prabhu
- Nima Bayan
- Shane Schofield
- Jenson Thomas
- Khaleelul Rahman Madathil
- Mohamed Ismail
- Jeremiah Manalastas
- Madhan Dharmarajan
- Suresh Kumar Chinnusamy
- Lakshminarayana Rao
- Hari Krishna Chalumuri
- Akshita K
- Siva Parvati V
- Bogati Naga Pushpa
- Purwa Nishikant
- Michelle Klein
- Aravind Deep
- Dana Childs
- Krishna Kant
- Dhruv Naik
- Karan Modgil
- Pulla Rao
- Venkat
- Sandeep Deekonda
- Lalit Yadav
- Sanjiva Reddy
- Sai Teja
Take Away Quote

“Alone we can do so little, TOGETHER WE CAN DO SO MUCH.” By Helen Keller